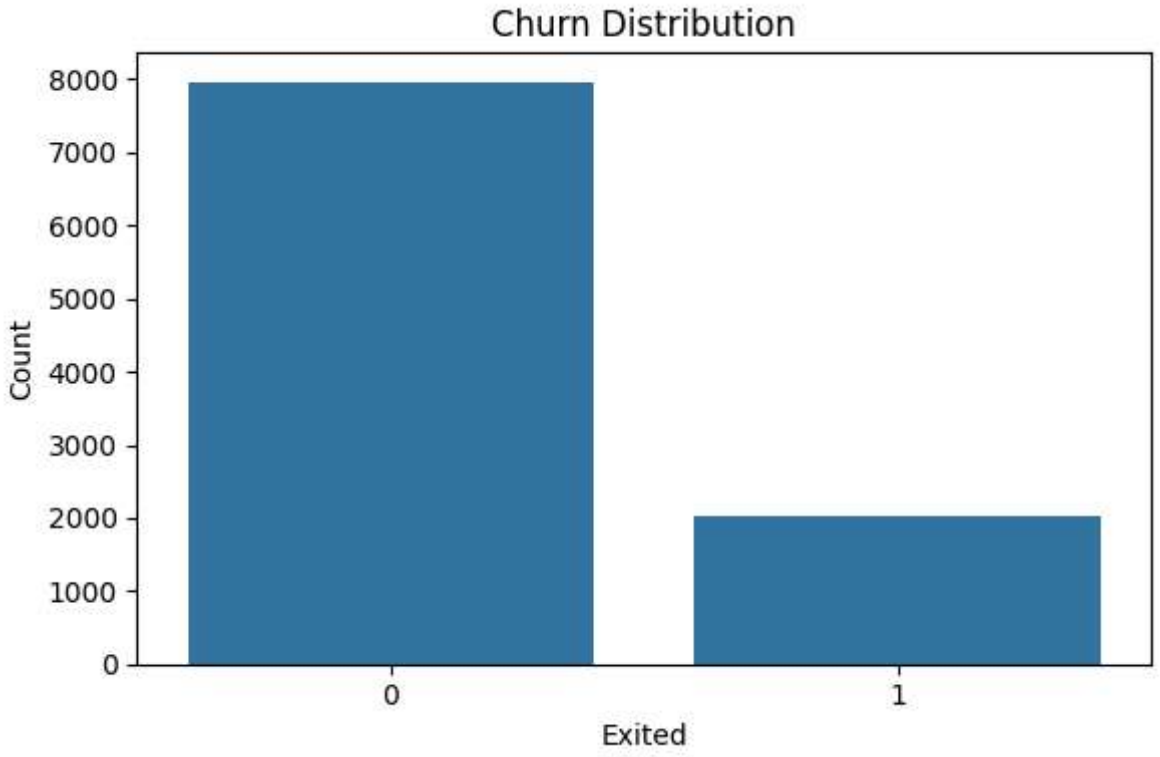
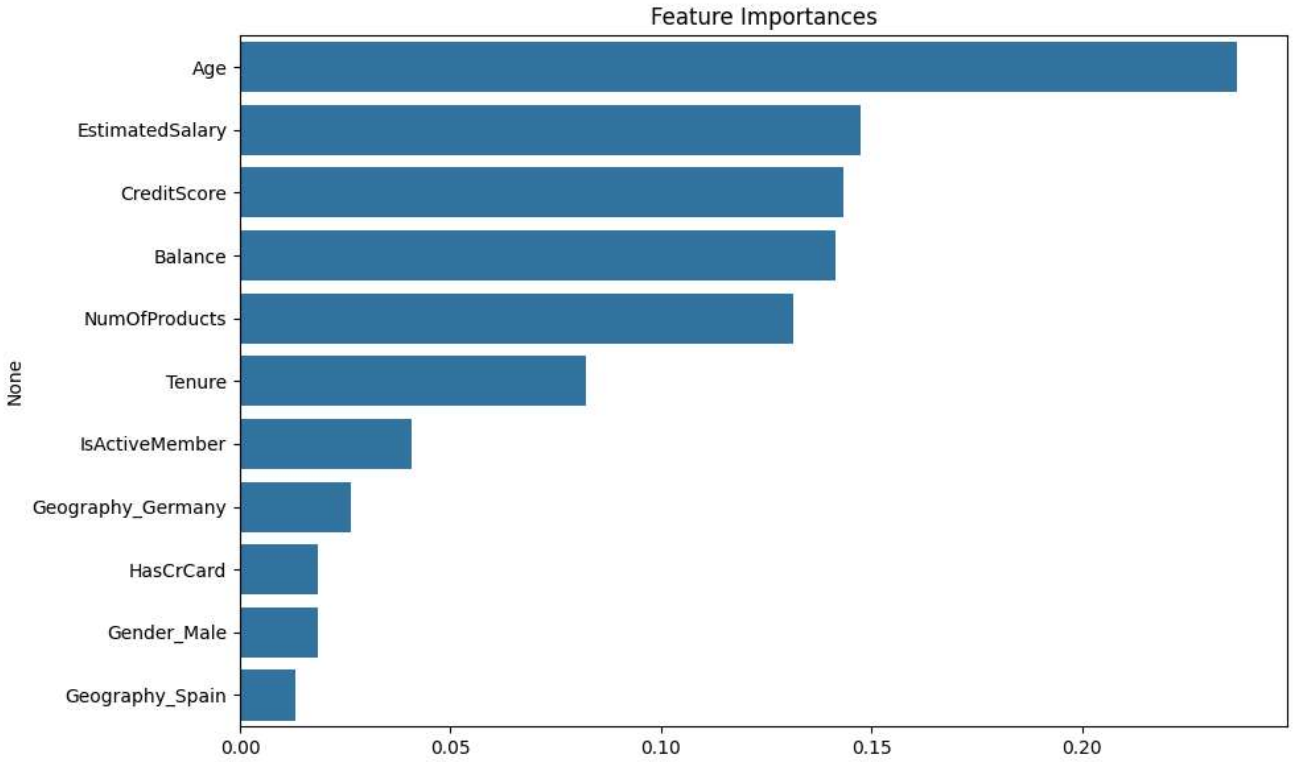
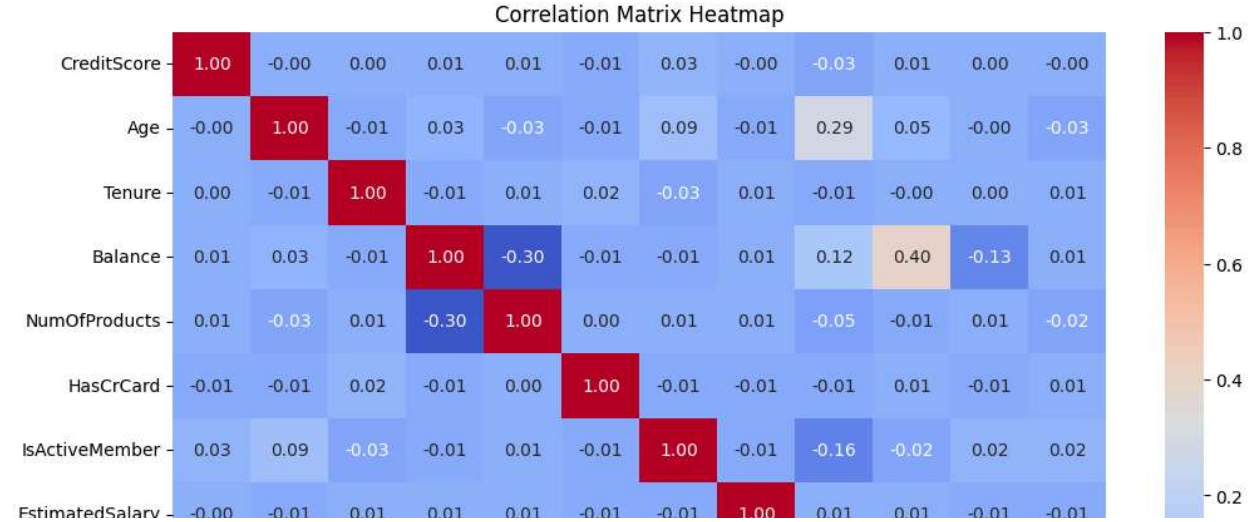
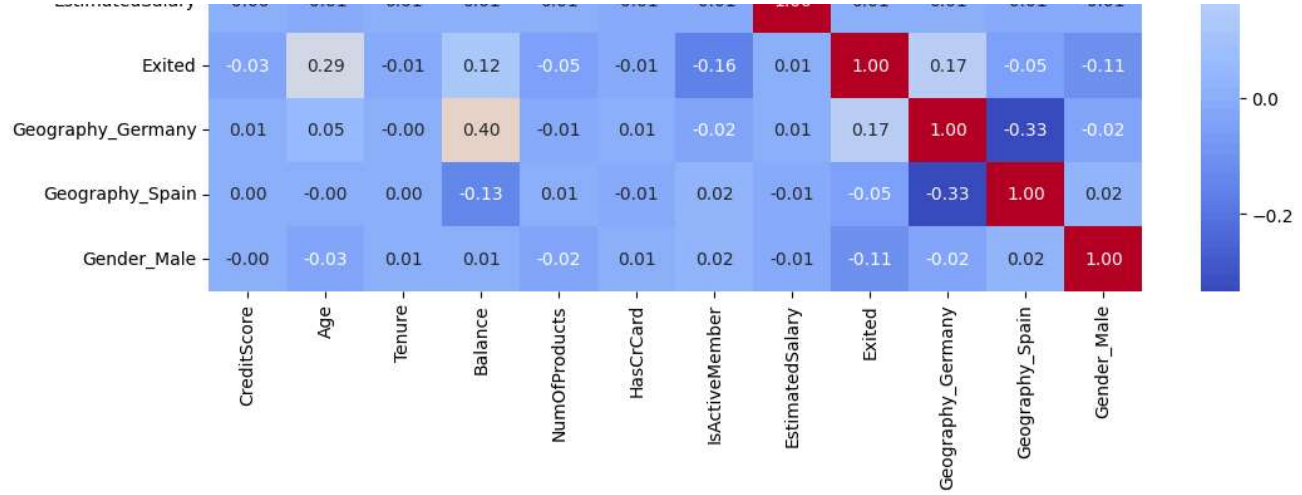
```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import classification_report, confusion_matrix
import joblib
import plotly.express as px

# Load dataset
df = pd.read_csv("Churn_Modelling.csv")

# Data Cleaning: Drop irrelevant columns
df_cleaned = df.drop(['RowNumber', 'CustomerId', 'Surname'], axis=1)

# EDA: Check missing values and churn distribution
missing = df_cleaned.isnull().sum()
churn_rate = df_cleaned['Exited'].mean()

# Visualization: Churn distribution
plt.figure(figsize=(6, 4))
sns.countplot(x='Exited', data=df_cleaned)
plt.title("Churn Distribution")
plt.xlabel("Exited")
plt.ylabel("Count")
plt.tight_layout()
plt.savefig("churn_distribution.png")
plt.show()

# Feature Engineering: One-hot encoding
df_encoded = pd.get_dummies(df_cleaned, columns=['Geography', 'Gender'], drop_first=True)

# Feature Scaling
scaler = StandardScaler()
X = scaler.fit_transform(df_encoded.drop('Exited', axis=1))
y = df_encoded['Exited'].values

# Model Development
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)
model = RandomForestClassifier(random_state=42)
model.fit(X_train, y_train)

# Evaluation
y_pred = model.predict(X_test)
report = classification_report(y_test, y_pred)
cm = confusion_matrix(y_test, y_pred)

# Visualization:
importances = model.feature_importances_
features = df_encoded.drop('Exited', axis=1).columns
indices = importances.argsort()[::-1]
```

```
plt.figure(figsize=(10, 6))
sns.barplot(x=importances[indices], y=features[indices])
plt.title("Feature Importances")
plt.tight_layout()
plt.savefig("feature_importances.png")
plt.show()

#heatmap
correlation_matrix = df_encoded.corr()
plt.figure(figsize=(12, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f")
plt.title("Correlation Matrix Heatmap")
plt.savefig("heatmap_modelling.png")
plt.show()

#plotly
fig = px.imshow(correlation_matrix,
                x=correlation_matrix.columns,
                y=correlation_matrix.columns,
                color_continuous_scale='RdBu_r',
                title="Correlation Matrix Heatmap")
fig.show()

# Save model
joblib.dump(model, "churn_model.pkl")

# Documentation
with open("model_report.txt", "w") as f:
    f.write("Missing Values:\n")
    f.write(str(missing) + "\n\n")
    f.write(f"Churn Rate: {churn_rate:.2f}\n\n")
    f.write("Classification Report:\n")
    f.write(report)

print(df)
```


Churn Distribution
Count
8000
7000
6000
5000
4000
3000
2000
1000
0
0
1
Exited


Feature Importances
None
Age
EstimatedSalary
CreditScore
Balance
NumOfProducts
Tenure
IsActiveMember
Geography_Germany
HasCrCard
Gender_Male
Geography_Spain
0.00
0.05
0.10
0.15
0.20


Correlation Matrix Heatmap
CreditScore 1.00 -0.00 0.00 0.01 0.01 -0.01 0.03 -0.00 -0.03 0.01 0.00 -0.00
Age -0.00 1.00 -0.01 0.03 -0.03 -0.01 0.09 -0.01 0.29 0.05 -0.00 -0.03
Tenure 0.00 -0.01 1.00 -0.01 0.01 0.02 -0.03 0.01 -0.01 -0.00 0.00 0.01
Balance 0.01 0.03 -0.01 1.00 -0.30 -0.01 -0.01 0.01 0.12 0.40 -0.13 0.01
NumOfProducts 0.01 -0.03 0.01 -0.30 1.00 0.00 0.01 0.01 -0.05 -0.01 0.01 -0.02
HasCrCard -0.01 -0.01 0.02 -0.01 0.00 1.00 -0.01 -0.01 -0.01 0.01 -0.01 0.01
IsActiveMember 0.03 0.09 -0.03 -0.01 0.01 -0.01 1.00 -0.01 -0.16 -0.02 0.02 0.02
EstimatedSalary -0.00 -0.01 0.01 0.01 0.01 -0.01 -0.01 1.00 0.01 0.01 -0.01 -0.01
1.0
0.8
0.6
0.4
0.2



Correlation Matrix Heatmap

CreditSc

Ten

Bala

NumOfProdu

HasCrC

IsActiveMem

EstimatedSa

Ex

Geography_Germ

Geography_Sp

Gender_M

```
      RowNumber  CustomerId    Surname  CreditScore Geography  Gender  Age  \
0             1    15634602   Hargrave          619    France  Female   42
1             2    15647311       Hill          608     Spain  Female   41
2             3    15619304       Onio          502    France  Female   42
3             4    15701354       Boni          699    France  Female   39
4             5    15737888   Mitchell          850     Spain  Female   43
...         ...         ...        ...          ...       ...     ...  ...
9995       9996    15606229   Obijiaku          771    France    Male   39
9996       9997    15569892  Johnstone          516    France    Male   35
9997       9998    15584532        Liu          709    France  Female   36
9998       9999    15682355  Sabbatini          772   Germany    Male   42
9999      10000    15628319     Walker          792    France  Female   28

      Tenure    Balance  NumOfProducts  HasCrCard  IsActiveMember  \
0          2       0.00              1          1               1
1          1   83807.86              1          0               1
```

```
2          8  159660.80              3           1                0
3          1       0.00              2           0                0
4          2  125510.82              1           1                1
...      ...        ...            ...         ...              ...
9995       5       0.00              2           1                0
9996      10   57369.61              1           1                1
9997       7       0.00              1           0                1
9998       3   75075.31              2           1                0
9999       4  130142.79              1           1                0

      EstimatedSalary  Exited
0           101348.88       1
1           112542.58       0
2           113931.57       1
3            93826.63       0
4            79084.10       0
...               ...     ...
9995         96270.64       0
9996        101699.77       0
9997         42085.58       1
9998         92888.52       1
9999         38190.78       0

[10000 rows x 14 columns]
```

```
!pip install gradio==3.32.0
```

```
Collecting gradio==3.32.0
  Downloading gradio-3.32.0-py3-none-any.whl.metadata (14 kB)
Collecting aiofiles (from gradio==3.32.0)
  Downloading aiofiles-24.1.0-py3-none-any.whl.metadata (10 kB)
Requirement already satisfied: aiohttp in /usr/local/lib/python3.11/dist-packages (
Requirement already satisfied: altair>=4.2.0 in /usr/local/lib/python3.11/dist-pack
Collecting fastapi (from gradio==3.32.0)
  Downloading fastapi-0.115.12-py3-none-any.whl.metadata (27 kB)
Collecting ffmpy (from gradio==3.32.0)
  Downloading ffmpy-0.5.0-py3-none-any.whl.metadata (3.0 kB)
Collecting gradio-client>=0.2.4 (from gradio==3.32.0)
  Downloading gradio_client-1.10.0-py3-none-any.whl.metadata (7.1 kB)
Requirement already satisfied: httpx in /usr/local/lib/python3.11/dist-packages (fr
Requirement already satisfied: huggingface-hub>=0.13.0 in /usr/local/lib/python3.11
Requirement already satisfied: jinja2 in /usr/local/lib/python3.11/dist-packages (f
Requirement already satisfied: markdown-it-py>=2.0.0 in /usr/local/lib/python3.11/c
Requirement already satisfied: markupsafe in /usr/local/lib/python3.11/dist-package
Requirement already satisfied: matplotlib in /usr/local/lib/python3.11/dist-package
Collecting mdit-py-plugins<=0.3.3 (from gradio==3.32.0)
  Downloading mdit_py_plugins-0.3.3-py3-none-any.whl.metadata (2.8 kB)
Requirement already satisfied: numpy in /usr/local/lib/python3.11/dist-packages (fr
Requirement already satisfied: orjson in /usr/local/lib/python3.11/dist-packages (f
Requirement already satisfied: pandas in /usr/local/lib/python3.11/dist-packages (f
Requirement already satisfied: pillow in /usr/local/lib/python3.11/dist-packages (f
Requirement already satisfied: pydantic in /usr/local/lib/python3.11/dist-packages
Collecting pydub (from gradio==3.32.0)
  Downloading pydub-0.25.1-py2.py3-none-any.whl.metadata (1.4 kB)
Requirement already satisfied: pygments>=2.12.0 in /usr/local/lib/python3.11/dist-p
Collecting python-multipart (from gradio==3.32.0)
  Downloading python_multipart-0.0.20-py3-none-any.whl.metadata (1.8 kB)
Requirement already satisfied: pyyaml in /usr/local/lib/python3.11/dist-packages (f
Requirement already satisfied: requests in /usr/local/lib/python3.11/dist-packages
Collecting semantic-version (from gradio==3.32.0)
  Downloading semantic_version-2.10.0-py2.py3-none-any.whl.metadata (9.7 kB)
Requirement already satisfied: typing-extensions in /usr/local/lib/python3.11/dist-
Collecting uvicorn>=0.14.0 (from gradio==3.32.0)
  Downloading uvicorn-0.34.2-py3-none-any.whl.metadata (6.5 kB)
Requirement already satisfied: websockets>=10.0 in /usr/local/lib/python3.11/dist-p
Requirement already satisfied: jsonschema>=3.0 in /usr/local/lib/python3.11/dist-pa
Requirement already satisfied: narwhals>=1.14.2 in /usr/local/lib/python3.11/dist-p
Requirement already satisfied: packaging in /usr/local/lib/python3.11/dist-packages
Requirement already satisfied: fsspec in /usr/local/lib/python3.11/dist-packages (f
Requirement already satisfied: anyio in /usr/local/lib/python3.11/dist-packages (fr
Requirement already satisfied: certifi in /usr/local/lib/python3.11/dist-packages (
Requirement already satisfied: httpcore==1.* in /usr/local/lib/python3.11/dist-pack
Requirement already satisfied: idna in /usr/local/lib/python3.11/dist-packages (frc
Requirement already satisfied: h11>=0.16 in /usr/local/lib/python3.11/dist-packages
Requirement already satisfied: filelock in /usr/local/lib/python3.11/dist-packages
Requirement already satisfied: tqdm>=4.42.1 in /usr/local/lib/python3.11/dist-packa
Requirement already satisfied: hf-xet<2.0.0,>=1.1.0 in /usr/local/lib/python3.11/di
Requirement already satisfied: mdurl~=0.1 in /usr/local/lib/python3.11/dist-package
Requirement already satisfied: linkify-it-py<3,>=1 in /usr/local/lib/python3.11/dis
INFO: pip is looking at multiple versions of mdit-py-plugins to determine which ver
Collecting mdit-py-plugins<=0.3.3 (from gradio==3.32.0)
  Downloading mdit_py_plugins-0.3.2-py3-none-any.whl.metadata (2.8 kB)
  Downloading mdit_py_plugins-0.3.1-py3-none-any.whl.metadata (2.8 kB)
  Downloading mdit_py_plugins-0.3.0-py3-none-any.whl.metadata (2.8 kB)
```

```
import gradio as gr
```

```
/usr/local/lib/python3.11/dist-packages/gradio_client/documentation.py:106: UserWarni

Could not get documentation group for <class 'gradio.mix.Parallel'>: No known documen

/usr/local/lib/python3.11/dist-packages/gradio_client/documentation.py:106: UserWarni

Could not get documentation group for <class 'gradio.mix.Series'>: No known documenta
```

```
def greet(name):
  return "Hello " + name + "!"

iface = gr.Interface(fn=greet, inputs="text", outputs="text")
iface.launch()
```

```
IMPORTANT: You are using gradio version 3.32.0, however version 4.44.1 is available,
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Colab notebook detected. To show errors in colab notebook, set debug=True in launch()
Note: opening Chrome Inspector may crash demo inside Colab notebooks.
```